REMARKS

Claims 1-23 remain in this application. Claims 1, 15, 16, and 22 are amended. Claims 24-38 have been withdrawn during a previously filed amendment. No new matter is introduced.

Applicant has amended the Specification to reflect the fact that the parent application has been issued as U.S. Pat. No. 6,602,567.

Claims 1-2 and 15-17 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 1-12 of U.S. Pat. No. 6,602,567, and over Claims 1-25 of U.S. Pat. No. 6,506,323. Applicant has executed a Terminal Disclaimer as attached herewith, and the Honorable Commissioner is authorized to charge the necessary statutory fee to Deposit Account 50-126-. Applicant respectfully submits that said Terminal Disclaimer should overcome the Examiner's obviousness-type double patenting rejections.

Claims 1-3, 5-6, 9 and 14-19 are rejected under 35 U.S.C. § 102(e) as being anticipated by Haggard et al. (US 2005/0032450); Claim 4, 7, 10-13, 20, 21, and 23 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Haggard et al. (US 2005/0032450) in view of Tour et al. (US 2004/0222081); and Claim 8 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Haggard et al. (US 2005/0032450) in view of Moy et al. (USPN 6,841,508). Applicant would like to traverse the Examiner's rejections below by pointing out several important differences between the carbon tube devices of the present invention and those taught by the references cited by the Examiner.

At the outset, Applicant respectfully submits that Applicant is fully aware that, although this is a product-by-process invention, the key criterion in determining its patentability is still "based upon the product formed and not upon the method by which it was produced". Ex parte Jungfer, 18 U.S.P.Q. 2d 1799 (B.P.A.I. 1990). However, Applicant would also like to respectfully point out that the unique process employed in the present invention has produced a product that is totally different

and patentably distinguishable from any of the carbon tube devices disclosed in the prior art, included those in the prior art references cited by the Examiner. In other words, many novel and nonobvious features of the carbon tube device of the present invention are direct results of the unique process from which the carbon tube device of the present invention is made.

In order to better illustrate the key elements of the carbon tube device of the present invention, Claim 1, as amended, is duplicated below:

Claim 1:

1. A device, comprising:

an assembled structure of a plurality of ***intimately adjoined*** carbonized carbon tubes, said assembled structure is prepared according to a process including the steps of:

coating a plurality of fibers with a carbonizable carbon-containing material to form a coating layer on each of said plurality of fibers;

assembling said plurality of coated fibers to form an assembled matrix;

binding said assembled matrix with one or more binding agents;

removing said plurality of fibers; and

carbonizing said coating layer and the residue of said fibers to form said assembled structure of the plurality of ***intimately adjoined*** carbonized carbon tubes.

Applicant respectfully submits that one of the key elements of the present invention, as recited in Claims 1 and 16, is that the carbon tubes are intimately adjoined together. This element

was never taught or suggested in any of the prior art references cited by the Examiner. Although this unique feature of the carbon tube device of the present invention is an inherent property of the unique process employed in the present invention, to avoid ambiguity, this key element is now explicitly recited in Claims 1 and 16. Such intimately adjoined structure of the carbon tube device of the present invention can be clearly seen in FIGs 2 and 7. No new matter is introduced. FIG. 7 also shows a unique honeycomb structure of the carbon tube device of the present invention. This forms the bases of the amended Claims 15 and 22.

The intimacy by which the individual carbon tubes of the carbon tube device of the present invention are adjoined, both laterally (or distance-wise, Fig. 7 shows that the adjoining individual carbon tubes actually share a common tube wall, in a structure similar to a honeycomb) and longitudinally (or length-wise, Figs. 2 and 7 show that the adjoining carbon tubes are adjoined through their entire lengths thereof), can only be achieved by the unique process employed in the present invention.

In the process employed in the present invention, the carbon tubes are assembled/adjoined in their precursor form (i.e., as the coating layer coated on the exterior of the sacrificial fiber) ***prior to*** their being carbonized. After the steps of removing the sacrificial fiber and carbonization, the resultant carbon tubes are intimately adjoined, both distance-wise and length-wise. This key element was never taught or suggested in any of the prior art references cited by the Examiner. For example, the Haggart et al reference taught a carbon tube device containing spaced-apart carbon tubes. On the other hand, the Tour et al reference proposed a method to spot-wise cross-link carbon tubes ***after*** the carbon tubes are formed. None of the prior art references cited by the Examiner, including the Haggard et al, the Tour et al, and the Moy et al references, taught or suggested a carbon tube device wherein the carbon tubes are intimately adjoined. Neither did any of these prior art references, either alone or in combination thereof, teach or suggest a process by which a carbon tube device with intimately adjoined carbon tubes can be prepared.

Applicant respectfully submits that, due to the intimacy between the individual carbon tubes,

the carbon tube device of the present invention, which contains intimately adjoined carbon tubes and is produced from the unique process also disclosed in the present invention, allows a maximum carbon tube density to be achieved per unit length. Indeed, Applicant respectfully submit, the carbon tube device of the present invention is not only novel and nonobvious, it is also superior to any other carbon tube device that is known in the market.

Applicant respectfully submits that it has been clearly established that "anticipation can only be established by a single prior art reference which discloses each and every element of the claimed invention". Structural Rubber Prod. Co. v. Park Rubber Co. 223 USPQ 1264 (Fed. Cir. 1984). It has been held by the Federal Circuit that in order "[f]or a prior-art reference to anticipate, every element of the claimed invention must be ***identically*** shown in a single reference" (*emphasis added*). In re Bond, 15 U.S.P.Q.2d 1566 (Fed. Cir. 1990). More recently the Federal Circuit reiterated that "a rejection for anticipation under section 102 requires that each and every limitation of the claimed invention be disclosed in a single prior art reference". In re Paulsen, 31 USPQ 2d 1671 (Fed. Cir. 1994).

Thus, Applicant respectfully submits that, as discussed above, the present invention recites a unique and superior carbon tube device whose carbon tubes are intimately adjoined. In comparison, the Haggart et al reference taught carbon tube devices containing carbon tubes that are spaced apart. The Haggart et al reference never taught or suggested carbon tube devices contain carbon tubes that are intimately adjoined. This difference is very significant in that, among other things, the carbon tube device of the present invention allows a substantially higher carbon tube density per unit length to be achieved. But more importantly, Applicant respectfully submits, since at least one key element of the present invention is missing from the prior art reference(s), it cannot be said as a matter of law that the present invention is anticipated. Therefore, Applicant respectfully submits that the Examiner's Section 102 anticipation rejection appears to be in error and must be withdrawn.

As discussed above, Applicant respectfully submits that Claims 1 and 16 should be

allowable. Claims 2-15 and 17-23, which depend from Claims 1 and 16, respectively, should also now be allowable. A dependent claim should be considered allowable when its parent claim is allowed. In re McCarn, 101 U.S.P.Q. 411 (CCPA 1954).

Because of the significance of the present invention, Applicant would like to provide further comments to support the patentability of the present invention. As briefly mentioned above, Haggard's patent as recited in Claim 1 thereof is about an apparatus for producing a nonwoven web product including ultra-fine fibers, comprising: a spin pack, a spinneret, an aspirator, and an elongated forming surface. This claim is irrelevant to the product of carbon tubes.

With respect to the "product" itself, Haggard's patent only taught how to prepare a matrix of loosely packed, individually isolated, and well-separated carbon tubes. The present invention teaches how to prepare a carbon tube device, comprising an assembled structure of a plurality of well-organized, densely packed, and intimately adjoined carbon tubes.

With respect to the process of making the carbon tube devices, Haggard's patent only taught how to make core/sheath fibers by a fiber-spinning method using an expensive and complicated apparatus, i.e. a specially designed spinneret. Haggard, however, did not teach how to prepare core/shell fibers using any of the coating methods of the present invention. Haggard's patent also only taught how to make core/sheath fibers from melt-processible materials. Their sheath materials were also greatly limited (as specified in Haggard's claim 19) to only polyacrylonitrile and the pitch-based materials. Therefore, Haggard's patent did not teach how to make core/shell fibers from the shell (or coating) materials that are not melt-processible. The present invention teaches how to prepare core/shell fibers basing on a wide range of coating materials, including those materials that are not melt-processible, such as those materials containing relatively long conjugated p-bonding segments (because their melting or softening points are, in general, higher than their initial degradation temperatures).

As discussed above, Haggard's patent only taught how to prepare an initially assembled

matrix of core/sheath fibers by the sea section materials (i.e., the first polymer component) using a specially designed spinneret apparatus. Such preparation method ensured those core/sheath fibers within their assembled structure (i.e., an islands-in-the-sea fiber) to be physically separated from each other by the sea section material, instead of contacting with each other. In the present invention, the assembling treatment renders the coated (core/shell) fibers physically and intimately contacted with each other.

The present invention further treats the assembled matrix of core/shell fibers with a binding step using one or more binding agents. Such binding treatment helps to ensure the core/shell fibers being significantly and intimately contacted with each other throughout the carbonization process. Under such circumstances, the carbonization of the assembled and bonded matrix of core/shell fibers will naturally lead to the formation of binding element (claim 16), such as an interfacial bonding interaction between the contacted surfaces of the carbonized coating layers, which helps to bind the plurality of the resultant carbonized carbon tubes to form an assembled structure of carbon tube device. Under the condition when the binding agent remains intimately in contact with the coating layer surfaces of the coated fibers either at the beginning of or during the carbonization process, the binding element among the carbon tubes can also be resulted from the carbonized binding agent (claim 17). On the other hand, although the original sea section of Haggard's inlands-in-the-sea fiber can be visualized as a binding agent for their core/sheath fibers, such binding agent (i.e., the sea section) was however removed (either fully or partially) before the carbonization treatment step (as specified in Haggards' claims 21 and p4 paragraphs 35 and 36) with a dissolving medium to render the core/sheath fiber physically separated from the sea section. Such separating treatment would destroy the binding function of the sea section, leaving behind a set of loosely packed and individually isolated plurality of core/sheath fibers, which contained no any component that could be considered and/or functioned as a binding agent. ***Under such circumstances, every sheath/core fiber would be physically separated from each other and also separated from any residual sea section***. Since the separation distances between the sheath/core fibers and/or between a sheath/core fiber and its surrounding sea section residue (if there was any) were all much larger than a van der Waals force contacting distance (i.e., a chemical bond formation distance), the formation of

interfacial bonding interaction between the carbonized sheath/core fiber and the carbonized sea section residue (if there was any) and/or between any two carbonized sheath/core fibers would then be very unlikely. Therefore, Haggard's plurality of carbon tubes would not contain the binding element of the present invention, which is responsible for binding the resultant plurality of carbonized carbon tubes to form an assembled structure of carbon tube device. As a result, not only Haggard's carbon tubes product failed to contain the binding element, but the Haggard's patent also never taught how to make such binding element.

The original binding agents in Haggard's patent were, however, subsequently removed, before the carbonization treatment step, by a dissolving medium to separate from the core/sheath fibers (as specified in Haggard's claims 21), thus losing its binding function. Therefore, Haggard's core/sheath fibers were actually carbonized without binding agents. Under such circumstances, the originally isolated and loosely packed set of plurality of core/sheath fibers would form an isolated and loosely packed set of plurality of carbon tubes, instead of a plurality of intimately adjoining carbon tubes as claimed in the present invention.

In summary, Haggard's patent taught a matrix of loosely packed, individually isolated, and well-spaced-apart carbon tubes. Whereas, the present invention recites a carbon tube device, comprising an assembled structure of a plurality of well-organized, densely packed, and significantly adjoined carbon tubes. The two devices are totally different and patentably distinguishable.

In Tour's patent, the microwave radiation was applied to carbon nanotubes ***after they are formed***. Whereas, in the present invention, the microwave radiation, if so used, is applied ***before*** the carbon tubes are formed by carbonization. In other words, in the present invention, the microwave radiation will be used as a binding agent to bind the coated fibers (i.e., the core/shell fibers) together, so that all the core/shell fibers will stick to each other throughout the carbonization process, which will eventually result in the formation of the binding element(s). The result is, in the present invention, the carbon tubes are intimately adjoined (as shown in Fig. 7., the adjoining carbon tubes actually share common tube walls which extend through the entire tube length, in a

honeycomb-like structure.) Whereas, according to Tour's patent, the carbon tubes will be crosslinked only at spaced apart locations, as shown in Fig. 5 of the Tour patent.

Just as what has been described in the above, the present invention recites a carbon tube device, comprising an assembled structure of a plurality of well-organized, densely packed and intimately adjoined carbon tubes. The assembling and binding treatments used in the present invention is the reason that causes the core/shell fibers to be in intimate contact with each other through the entire tube length and throughout the carbonization process, thus ensuring the formation of a binding element among the subsequently formed carbon tubes and resulting in the final assembled carbon tube device with significant mechanical strength and physical integrity. In comparison, Haggard's patent taught a plurality of loosely packed, individually isolated, and well-separated carbon tubes. Haggard's patent also used a complicated and expensive assembling method (for making the original plurality of sheath/core fibers) and a subsequent separating pretreatment (for removing the original sea section with a dissolving medium to produce the well-defined sheath/core fibers) to ensure that all the sheath/core fibers would separate from the sea section residue (if there was any) and also separate from each other during the carbonization process. Such separations actually also inhibited the formation of binding element(s) among the resultant carbon tubes. It is clear that the process disclosed in the Haggard reference could not produce the same final carbon tube structure as claimed in the present invention.

As discussed above, the Tour reference taught that when subjected to microwave radiation, the already-formed carbon tubes having a specific graphitic carbon layer structure (Tour's Fig. 5) might fuse together at the some closely contacted surface spots. Tour et al, however, did not teach how to assemble the carbon tubes together into a well-organized and workable carbon tube device having a predetermined shape and a controllable size. This inadequacy causes the longitudinal (i.e., length-wise) intimacy between the adjoining carbon tubes to be totally lacking. The Tour reference did teach how to use microwave radiation in making blocks or panels of a particular type of carbon tube, i.e., single wall carbon nanotube. However, such teaching is not generally applicable to other types of carbon tubes, because a single wall carbon nanotube has a very different chemical structure,

and hence very different chemical reactivity and/or physical property from all other carbon tubes. The Tour reference also indicated that carbon nanotubes have shown unusual responsive behaviors to microwave radiation. When carbon nanotubes were subjected to microwave radiation in air, they ignited (p. 1, paragraph 6). When carbon nanotubes were subjected to microwave radiation in UHV, they emitted light (p. 2, paragraph 14; and p. 3, paragraph 27). Such unusual responsive behaviors to microwave radiation were only found in metals, but not found in all other types of carbon-containing materials. Therefore, although Tour's patent did teach how microwave radiation interacted with carbon nanotubes, it however did not teach how microwave radiation will interact with the coating layers of the present invention (i.e., precursors of the final carbon tubes). In summary, the method proposed in the Tour patent may allow spaced apart carbon tubes to be tied together with a spot-wise crossling process, this is totally different and clearly distinguishable from the carbon tube structure of the present invention, where the carbon tubes are intimately adjoined in a structure similar to that of a honeycomb.

Regarding the host materials, Tour's patent indicated that as the polymer composite and/or blend containing carbon nanotubes was irradiated with microwave, the carbon nanotubes only served as a conduit for thermally and/or photolytically curing and/or crosslinking the host matrix (p.1-2, paragraph 10). Under such conditions, Tour's patent also clearly indicated that the common unmodified (i.e., without being appropriately functionalized) carbon nanotubes would not form the interfacial crosslinking bonds with the polymer host matrix; nor would they crosslink among themselves unless the employed polymer host matrix was so thermally stable that it could survive the above-mentioned thermal heating generated during the microwave radiation treatment. Therefore, under the above conditions, the incorporated carbon nanotubes were only individually (or locally) included in the host polymer matrix without forming the binding element between the carbon nanotubes and the host polymer matrix or among the carbon nanotubes. In some embodiments of Tour's patent (p.4, paragraph 41), the crosslinked carbon nanotubes were further incorporated into a host matrix, such as metals and some inorganic materials, to impart desirable properties to the resulting composite and/or blends. In common practices, such application normally requires the additive or the modifier (i.e., the crosslinked carbon tubes) being homogenously dispersed in the host

matrix (i.e., metals and other inorganic materials). Therefore, in these embodiments of Tour's patent, the products were the modified host matrix that contained the homogeneously dispersed and individually clustered carbon nanotubes as the modifiers or additives. Whereas, the products of the present invention are the assembled carbon tube device comprising a plurality of intimately adjoined carbon tubes that are further held together by some binding agents, such as metals and other inorganic network structure.

Since Haggard's reference taught a plurality of loosely packed, individually isolated, and well-separated carbon tubes, they were not physically contacting with each other. Such spacious separation would inhibit the formation of any interfacial bonding interactions (including fused and/or interpenetrated carbon wall structures) among the carbon nanotubes, even if they were subsequently subjected to microwave radiation after their preparation. Therefore, the combination of Haggard's reference and Tour's reference still cannot generate the claimed carbon tube device of the present invention.

With regard to the Moy et al reference, Claim 1 of Moy's patent related to an oxidation method for converting the carbide-based nanorods into oxycarbide-based nanorods. As dicussed above, Haggard's patent did not teach how to make the carbon tube device which contains intimately adjoined carbon tubes as claimed in the present invention. The hydrogen peroxide was used in the Moy's patent as an oxidizing agent (as specified in Moy's patent: col.12, line 25) for oxidizing the inner surface of the carbon nanotubes to render it suitable for the subsequent impregnation of catalytic particles (Moy's patent: col. 12, lines 24-30). Clearly, the hydrogen peroxide in Moy's patent did not and could not serve as a crosslinking agent for the carbon nanotubes, because the tubes were well separated from each other by a space of about 10-30 nm (col.12, lines 9-10) that is much longer than the distance for forming a chemical bond (Typically. less than 0.2 nm). Therefore, the formation of interfacial crosslinking bonds (i.e., a typical binding element) among Moy's carbon nanotubes is very unlikely. On the contrary, the peroxides claimed in claim 8 (including hydrogen peroxide) of the present invention work as crosslinking agents only for the ***coated fibers*** (i.e., for the precursors of the carbon tubes ***prior to carbonization*** and not for the subsequently formed carbon

tubes). Owing to the general reactive natures of peroxides, most of the peroxides will be consumed during the binding treatment step. Any residual peroxides will also be decomposed at temperatures well below 200 °C, which is much lower than the initial carbonization temperatures (around 300-500 °C) of the coating layer materials. As a result, in the present invention, most if not all the peroxides would disappear long before the carbon tubes begin to be formed. So, the peroxides used in the present invention act as the crosslinking agents for the coated fibers, and not for the carbon tubes.

The hydrogen peroxide in Moy's patent only worked as an oxidation reagent and did not cause crosslinking reactions between the carbon tubes (owing to the fact that the carbon tubes were well-separated from each other by a distance of about 10-30 nm). Similar results will be obtained when hydrogen peroxide is applied to Haggard's carbon tubes, because Haggard's carbon tubes were also well separated in space from each other, which separation inhibited the formation of interfacial crosslinking bonds among the carbon tubes. Whereas, in the present invention the hydrogen peroxide is used as a binding agent, which causes the formation of interfacial crosslinking bonds between the intimately contacted surfaces of the coating layer of the core/shell fibers. Such interfacial crosslinking bonds help to keep the core/shell fibers sticking to each other during the entire carbonization process, leading to the formation of final binding element between the subsequently formed carbon tubes.

In summary, Applicant has reviewed the prior art references cited by the Examiner and found that none of the references, either alone or in combination thereof, taught or suggested many of the key elements of the present invention. Applicant respectfully submits that, since many of the important limitations are lacking from the prior art teaching, not only the present invention is not anticipated, a prima facie case of obviousness also cannot be made. In re Fine, 5 USPQ2d 1596 (Fed. Cir. 1988).

In light of the foregoing, it is believed that the present invention is in condition for allowance. And Applicant respectfully requests that a timely Notice of Allowance be issued in this case. If the Examiner has any question, he or she is invited to call or fax Applicant's counsel at the telephone

numbers below.

Respectfully Submitted,

5/12/05
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